ISSN 2521-4012

臺灣研蟲誌

Taiwanese Journal of Entomological Studies

第七卷，第三期

臺灣昆蟲同好會

Taiwanese Society of Insect Natural History

Vo. 7, No. 3, September 25, 2022

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[研究文章 Research Article]

http://doi.org/10.5281/zenodo.7100644

The Genus *Sympetrum* Newman, 1833 (Odonata: Libellulidae) in Taiwan: Distribution, Bionomics and a Report of a Newly Recorded Species

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Abstract: We summarize the bionomics, distributional information, and habitus photos of all Taiwanese *Sympetrum*, including *S. bacha bacha*, *S. cordulegaster*, *S. darwinianum*, *S. depressiusculum*, *S. eroticum ardens*, *S. fonscolombii*, *S. infuscatum*, *S. kunckeli*, *S. nantouensis* and *S. speciosum*. *Sympetrum infuscatum* is reported from Taiwan for the first time, based on a photo taken on 07 October 2009 in Keelung City. A new record of *S. darwinianum* found on 09 October 2010 in New Taipei City is reported, representing the second record of the species in Taiwan. Distributional maps of all species and phenological graphs, based on 25 years of citizen science data of 6 selected species (*S. cordulegaster*, *S. depressiusculum*, *S. eroticum ardens*, *S. fonscolombii*, *S. nantouensis* and *S. speciosum*) are also provided.

Keywords: Dragonfly, vagrant dragonfly, migration, citizen science, bionomics, east Palearctic, Oriental

Introduction

Sympetrum is a Holarctic speciose genus with 56 species (Schorr & Paulson, 2022) and multiple undescribed species in China (Zhang, 2019). Within Taiwan, 9 species of *Sympetrum* have been reported (Lieftinck et al., 1984; Tsou & Yeh, 2007; Yeh et al., 2007; Tang et al., 2013). Among them, 3 species were considered vagrant species, which can only be observed during a short period of time during autumn. *Sympetrum fonscolombii* represents the first reported vagrant dragonfly in Taiwan by Tsou & Yeh (2007). After that, Yeh et al. (2007) reported *S. cordulegaster* and *S. depressiusculum* as vagrant dragonflies on the island for the first time. *Sympetrum eroticum ardens* and *S. speciosum* are resident species with stable observations and collecting records (Asahina, 1951; Inoue & Takahashi, 1969; Matsuki & Lien, 1983; Lieftinck et al., 1984). Tang et al. (2013) described the endemic *S. nantouensis* as one of the few cases in which a species of *Sympetrum* is restricted to a small region. It also represented the third known resident species. A couple of species are considered locally extinct or only occasionally recorded as vagrants. *Sympetrum bacha bacha* has no further collecting or observing records since 1978 (Inoue & Takahashi, 1969; Matsuki & Lien, 1983); *S. darwinianum* and *S. kunckeli* were only reported once, and no other records have been reported (Asahina, 1940; Inoue & Takahashi, 1969).

We review the fauna of *Sympetrum* in Taiwan and report the first record of *S. infuscatum* in Taiwan, based on a photo taken in 2009 from Keelung. Furthermore, thanks to the citizen science data contributed since 1995 by Taiwanese amateur odonatologists, we summarized the distributional and phenological data and for all species of *Sympetrum*, which are frequently recorded in Taiwan.

Materials and methods

Distributional maps are based on data from the following citizen science websites: iNaturalist (Aru, Taiwan Dragonflies & Damselflies, https://www.inaturalist.org/projects/taiwan-dragonflies-damselflies), Nature Campus (Szu-Lung Chen, Horizontal Distribution of Taiwan Odonata, Supplementary data 1 (http://doi.org/10.5281/zenodo.7056442)), and Observation Database of Taiwanese Odonata (Chi-Ming Lou, personal communication). Geographic coordinates from observations are approximate and obtained from searches of localities and their subsequent georeferencing using Google Earth software. We approximate the coordinates as the center of the respective locality for those localities with only large-scale place names. We remove the repeat

稿件收到 *Received: 31 July 2022*

稿件接受 *Accepted: 7 September 2022*

稿件出版 *Published: 25 September 2022*

localities from the map, hence the map only indicates the distributional status, not observation frequency about a specific locality. The data were extracted on 30 July 2022. The distributional map was prepared in SimpleMappr (Shorthouse, 2010).

The data used to make the phenological graphs were extracted from the Observation Database of Taiwanese Odonata (Chi-Ming Lou, personal communication). In total, 1,688 date records were extracted to produce the graphs. The records for each species are summarized in Table 1. However, we did not make the phenological graphs for those species that are locally extinct or occasionally recorded (*Sympetrum bacha bacha*, *S. darwinianum*, *S. infuscatum*, *S. kunckeli*).

Table 1. Records of selected *Sympetrum* species extracted from Observation Database of Taiwanese Odonata.

Species	Recorded years	Recorded numbers
Sympetrum cordulegaster (Selys, 1883)	2006–2020	186
Sympetrum depressiusculum (Selys, 1841)	2008–2019	37
Sympetrum eroticum ardens (MaLachlan, 1894)	1995–2022	728
Sympetrum fonscolombii (Selys, 1840)	2004–2021	339
Sympetrum nantouensis Tang, Yeh & Chen, 2013	2008–2021	184
Sympetrum speciosum Oguma, 1915	1996–2022	214

Results

Resident species

焰紅蜻蜓

***Sympetrum eroticum ardens* (MaLachlan, 1894)**

(Figs 1A–D, 2)

Distribution.

The subspecies is widely distributed in southern China (Anhui, Hubei, Hunan, Sichuan, Chongqing, Yunnan, Guizhou, Zhejiang, Fujian and Guangdong), Taiwan and Vietnam (Zhang, 2019).

In Taiwan, the main population is in northern Taiwan (Taipei, New Taipei, Keelung, Taoyuan, Hsinchu, Yilan), with a few records from central Taiwan (Miaoli, Taichung, Nantou). Ris (1916) reported a few specimens of *S. eroticum ardens* collected from Taihorin (=Dalin 大林), Chiayi County in southern Taiwan (Fig. 2A). There are no further records of this species from southern Taiwan in the last five decades.

Bionomics.

Adults are active for almost the whole year, but the most activity occurs from October to December, and the newly emerged adults can be occasionally observed from May to September (Fig. 2B). The newly emerged adults are easily found in higher mountain areas (ca. 1100 m) during the summer. In autumn and winter, the adults will concentrate in lowland ponds or rice fields (under 400 m). The majority of adults will disappear in February. Only a few adults have been recorded from February to March. The migration is similar to Japanese *S. frequens* (Selys, 1883), which migrate during autumn (Miyakawa, 1994). Further observations of the migration of *S. eroticum ardens* are needed to understand it in detail.

Remarks.

Sympetrum eroticum ardens is sympatric with *S. nantouensis* in some localities in Nantou County, such as the pond of Endemic species research institute (特有生物研究保育中心) and Lienhuachi (蓮華池), but the population is distinctly lower than *S. nantouensis*.

纖紅蜻蜓

***Sympetrum nantouensis* Tang, Yeh & Chen, 2013**

(Figs 1E–H, 3)

Distribution.

The species is restricted in Nantou County in central Taiwan (Tang et al., 2013) (Fig. 3A).

Bionomics.

Adults appear from May to the January of the succeeding year, but most mature adults can be observed during August to November (Fig. 3B). They occur in grassy marsh habitat adjacent to the forest at an elevation between 250–800 m. For detailed bionomics see Tang et al. (2013).

Remarks.

Tang et al. (2013) indicated that *S. nantouensis* was only recorded in four townships in Nantou County: Guoxing Township (國姓鄉), Puli Township (埔里鎮), Yuchi Township (魚池鄉), Shuili Township (水里鄉). According to the data from supplementary data 1, the species has also been found in the pond of the Endemic species research institute (特有生物研究保育中心) in Jiji Township (集集鎮) and Youzhi tea garden (有志茶園) in Lugu Township (鹿谷鄉).

黃基蜻蜓

***Sympetrum speciosum* Oguma, 1915**

(Figs 4A–C, 5)

Distribution.

The species is widespread in east Asia, including Japan, Taiwan, Mongolia, China, Korea, northern Vietnam, northern and eastern India, Bhutan and Nepal (Sasamoto et al., 2018; Zhang, 2019; Kalkman et al., 2020; Ozono et al., 2022).

In Taiwan, the species is widely distributed in mountain areas, including New Taipei, Taoyuan, Hsinchu, Miaoli, Taichung, Nantou, Yunlin, Chiayi, Kaohsiung, Yilan, Hualien and Taitung (Fig. 5A).

Bionomics.

Adults appear from May to the January of the succeeding year, but most mature adults can be observed from July to September (Fig. 5B). The largest population can be found in open ponds in high mountains at elevations of 680–3500 m.

Remarks.

There are few records from relatively low elevations, such as Taiping Village (泰平里) (ca. 150 m) in New Taipei City and Xiapi (下埤) (ca. 600 m) in Yilan County. The species may exhibit vertical migration behavior from high mountains to low mountains. However, further observations are needed to confirm this.

Vagrant species

紅脈蜻蜓

***Sympetrum fonscolombii* (Selys, 1840)**

(Figs 4D–F, 6)

Distribution.

The species is extremely widespread in Asia, Europe and Africa (Tsou & Yeh, 2007; Zhang, 2019).

In Taiwan, the species is recorded from nearly all counties near the coast and the islands around Taiwan island, including Taipei, New Taipei, Keelung, Taoyuan, Hsinchu, Miaoli, Taichung, Changhua, Yunlin, Chiayi, Tainan, Kaohsiung, Pingtung, Yilan, Taitung, Penghu, Kinmen, Lianjiang (Fig. 6A).

Bionomics.

Adults appear from May to December in China (Zhang, 2019). In Japan, the species is considered a vagrant species (etc., Futahashi, 2004; Tsou & Yeh, 2007; Borisov et al., 2020a, b; Ozono et al., 2022), and most adults are found from late September to early November (Ozono et al., 2022). In Taiwan, all records are from September to November, but most records are in October (Fig. 6B). The oviposition behavior and newly emerged adults have been recorded in Japan, but no population has been established (Sugimura et al., 1999; Ozono et al., 2022). The adults were frequently observed to inhabit the low plants on the seashore. In October 2018, over 50 individuals were found on Beidi beach, Bali District, New Taipei City (八里區北堤沙灘) in one day by the second author. Multiple pairs of adults mating and laying eggs on small puddles in the same locality were observed by an amateur odonatologist (Harn-Ian Chiou 秋寒煙).

Remarks.

The photos of *S. fonscolombii* recorded from Songluo Lake (松羅湖, ca. 1200 m) in Yilan County on 28 October 2018 were published on Facebook. This record indicated that the migratory population of *S. fonscolombii* in Taiwan might also enter the inland mountains and is not only restricted near the seashore region or nearby. Another interesting record from Dongsha Island (東沙島) (20.701, 116.728, not mapped in the Fig. 6) on 22 October 2012 on Nature Campus represents the southernmost record of the species in Taiwan.

長尾蜻蜓

***Sympetrum cordulegaster* (Selys, 1883)**

(Figs 7A–D, 8)

Distribution.

The species is distributed in northeastern China (Heilongjiang, Jilin, Liaoning), Taiwan, Japan, Korea and Russia (Far East) (Yeh et al., 2007; Zhang, 2019; Ozono et al., 2022).

Most records are from northern Taiwan and there are limited reports from offshore islands, including Taipei, New Taipei, Keelung, Hsinchu, Yilan, Penghu, and Kinmen (Fig. 8A).

Bionomics.

Adults appear from June to October in China (Zhang, 2019). In Japan, the species is considered a vagrant species (etc., Futahashi, 1996; Futahashi & Futahashi, 1999; Yeh et al., 2007; Ozono et al., 2022), most adults are found from late September to early November, but with a resident population in Tsushima (Sugimura et al., 1999; Ozono et al., 2022). In Taiwan, all records are from September to November, but most records are in October (Fig. 8B). The species can be observed in open ponds near the seashore, especially in Keelung in northernmost Taiwan. The copulation and oviposition of the species are reported from Japan (Futahashi et al., 2001b) and Taiwan (Yeh et al., 2007).

Remarks.

Among three vagrant species of *Sympetrum* in Taiwan, there are distinctly fewer records of *S. cordulegaster* than *S. fonscolombii* but higher than *S. depressiusculum*.

秋紅蜻蜓

Sympetrum depressiusculum (Selys, 1841)

(Figs 7E–H, 9)

Distribution.

The species is distributed in northern and northeastern China (Heilongjiang, Jilin, Liaoning, Inner Mongolia, Beijing), Taiwan, Korea, Japan, Ukraine, Iraq, Turkey, France, Spain, Russia (Siberia), Middle Asia, Eastern and Central Europe, and Northern Africa (Algeria) (Yeh et al., 2007; Zhang, 2019; Ozono et al., 2022).

In Taiwan, all records are from northern Taiwan, including Taipei, New Taipei and Keelung (Fig. 9A).

Bionomics.

Adults appear from June to October in China (Zhang, 2019). In Japan, the species is considered a vagrant species (etc., Futahashi & Futahashi, 1999; Futahashi et al., 2000; Yeh et al., 2007; Ozono et al., 2022), most adults are found from late September to early November but with a resident population in Tsushima (Sugimura et al., 1999; Ozono et al., 2022). In Taiwan, all records are from September to October, but most records are in October (Fig. 9B). The species can be observed in open ponds near the seashore in Taiwan, especially in Keelung in northernmost Taiwan. The newly emerged adults can be bred from the eggs laid by migrated females in Japan (Futahashi et al., 2001a).

Remarks.

Among three vagrant species of *Sympetrum* in Taiwan, *S. depressiusculum* is the rarest species.

Locally extinct or status unknown species

赤衣蜻蜓

Sympetrum bacha bacha (Selys, 1844)

(Figs 10A–B, 13)

Distribution.

This subspecies is widely distributed in China (Henan, Anhui, Zhejiang, Fujian, Guizhou, Sichuan, Hubei, Hunan, Jiangxi, Guangdong) and Taiwan (Zhang, 2019).

In Taiwan, the species have been collected from Taipei, New Taipei, Taoyuan, Taichung and Pingtung (Matsuki & Lien, 1983). The distributional records are summarized in Fig. 13.

Bionomics.

Adults appear from June to November in China (Zhang, 2019) and from May to October in Taiwan (Matsuki & Lien, 1983). They occur in wetland habitats with an elevation below 2000 m in China (Zhang, 2019). Lieftinck et al. (1984) reported that the species inhabited the plains and hills below 500 m in Taiwan.

Remarks.

Inoue & Takahashi (1969) and Matsuki & Lien (1983) reported several records of *S. bacha bacha* in northern Taiwan based on specimens that were collected from 1968 to 1978. Nowadays, and during the recent decades, Odonata observations are increasing

all the time. The species has never been collected or reported since 1978. Hence, the species is currently considered locally extinct (Tang et al., 2013).

孔凱蜻蜓
Sympetrum kunckeli (Selys, 1884)

(Figs 10C–D, 13)

Distribution.

The species is widely distributed in the eastern Palearctic region, including China (Jilin, Liaoning, Beijing, Hebei, Shanxi, Shandong, Henan, Anhui, Shaanxi, Hubei), Japan, Korea, Russia (Far East) and Taiwan (Zhang, 2019; Ozono et al., 2022).

In Taiwan, the species was only collected once in Nanshanshi (南山溪) in the central part of the island (Inoue & Takahashi, 1969) (Fig. 13).

Bionomics.

Adults appear from June to September in China (Zhang, 2019), and from April to December in Japan, but the majority of the Japanese population is from early July to early November (Ozono et al., 2022). The Taiwanese specimen was collected in early July. The habitats it occurs in are lowland ponds, wetlands, or abandoned rice fields near the forests in China and Japan (Zhang, 2019; Ozono et al., 2022).

Remarks.

The species in China and Japan are not vagrant species (Zhang, 2019; Ozono et al., 2022). The Taiwanese specimen was deposited in the National Museum of Nature and Science, Tsukuba, Japan, which was confirmed and examined by Futahashi & Kiysohi (2022). Therefore, it may be considered that the Taiwanese population of *S. kunckeli* is locally extinct, such as the status of *Aristocypha baibarana* (Matsumura, 1931) and *Fukienogomphus prometheus* (Lieftinck, 1939) in Nanshanshi region (Lin & Yang, 2016; Hu et al., 2021).

仲夏蜻蜓
Sympetrum darwinianum (Selys, 1883)

(Figs 11A–B, 13)

Distribution.

The species is widely distributed in China (except in the northwest region), Taiwan, Korea, Japan and Russia (Nagahata et al., 2017; Zhang, 2019; Ozono et al., 2022). However, the species has only been recorded from Taiwan twice, Asahina (1940) reported a specimen from "Sikikun" (= Siji 四季) in Yilan County; and a photo record by Chin-Li Chiang (江進利) in Linshanbi (麟山鼻) in New Taipei City on 09 October 2010 (data extracted from Observation Database of Taiwanese Odonata) (Fig. 13).

Bionomics.

Adults appear from June to December in China and Japan (Zhang, 2019; Ozono et al., 2022). The specimen reported by Asahina (1940) was collected in mid-August. The newly recorded specimen from Linshanbi was observed on 09 October 2010, the locality is near the seashore without freshwater in the surroundings. It occurs in lowland ponds, wetlands and rice fields in China and Japan (Zhang, 2019; Ozono et al., 2022).

Remarks.

Asahina (1940) commented that the Taiwanese specimen is larger than the Japanese specimens (hind wings 32 mm compared to 27–28 in Japanese specimens). However, it is still within the range when measuring more Japanese specimens (Ozono et al., 2022).

A few specimens of *S. darwinianum* were reported as migratory individuals in Amami-Oshima and Niijima-mura in Japan (Ozono et al., 2022). In addition, the newly found specimen in Linshanbi which was not inhabiting the standard habitat may indicate that the species migrated to Taiwan from elsewhere.

褐頂蜻蜓
Sympetrum infuscatum (Selys, 1883)

(Figs 11C–D, 12, 13)

Distribution.

The species is widely distributed in China (except the northwest region and Hainan), Russia (Far East), Korea and Japan (Zhang, 2019; Ozono et al., 2022). The species is newly recorded in Taiwan in the present study, based on a photo record from Keelung City in northern Taiwan (Figs 12, 13).

Bionomics.

Adults appear from late May to early December in Japan (Ozono et al., 2022); from June to October in China (Zhang, 2019). The habitat are lowland wetlands, ponds, and rice fields (Zhang, 2019; Ozono et al., 2022). A male specimen was photographed by Harn-Ian Chiou (秋寒煙) on 07 October 2009 in Qiuhong Lake (秋紅湖). Notably, over 50 individuals of *S. cordulegaster* were observed on the same day in Qiuhong Lake by Harn-Ian Chiou (秋寒煙).

Remarks.

Sympetrum infuscatum is fairly common in Japan but was not considered a vagrant species (Ozono et al., 2022). However, since Qiuhong Lake is one of the famous vagrant dragonfly hot spots (all three vagrant species of *Sympetrum* are frequently reported from Qiuhong Lake) and no other records of the species from different places, the species is hypothesized to arrive in Taiwan occasionally, but further observations of the species are needed to confirm the status.

Discussion

Some species of dragonfly are well-known as migratory animals. The best-known example is *Pantala flavescens* (Fabricius, 1789) which migrates from India to Africa in the tropical Indian Ocean through ITCZ and monsoons (Anderson, 2009; Hobson et al., 2012; Hedlund et al., 2021) or migration cases of other places worldwide (Feng et al., 2006; Hobson et al., 2020). Miniaturized radio transmitters or isotopes are widely adapted to the studies of migration animals, including dragonflies, to study their origin or migration strategy (Hobson et al., 2012, 2020; Hallworth et al., 2018; Knight et al., 2019; Borisov et al., 2020a). Within the genus *Sympetrum*, many migratory records have been reported in the Holarctic, including Asia, Europe and America (etc., Arnaud, 1972; Futahashi, 1996; Yeh et al., 2007; Knoblauch et al., 2021). But the detailed study of such a phenomenon on *Sympetrum* is still limited, and most experiments are done in Middle Asia and Europe (etc., Borisov et al., 2020b; Knoblauch et al., 2021) and therefore studies on *Sympetrum* in the eastern Palearctic and Oriental region are still lacking. Taiwan is more likely the staging site for the migrated *Sympetrum* since the majority of individuals only stay two to three days and then disappear. Though a few oviposition records were observed, it seems Taiwan is not their terminal place. It is still unclear whether or not migration is required for the life stage. It is also possible these individuals were transported by monsoons accidentally. Integrative miniaturized radio transmitters and isotope tracking may solve the puzzle of migration of *Sympetrum* in the eastern Palearctic region.

In Japan, a couple of species of *Sympetrum* (*S. fonscolombii*, *S. darwinianum*, *S. maculatum*, *S. gracile*, *S. flaveolum*, *S. danae*, *S. frequens*, *S. depressiusculum*, *S. vulgatum*, *S. eroticum*, *S. cordulegaster*, *S. speciosum* and *S. uniforme*) have been reported as migratory records (Ozono et al., 2022). The newly recorded species *S. infuscatum* and *S. darwinianum* hint that other species of *Sympetrum* distributed in nearby countries are highly likely to be found in Taiwan. Increasing the survey frequency during the migration season in autumn, especially during or after extreme weather events such as the intense northeast monsoons, may further our understanding of the Taiwanese fauna of *Sympetrum*.

Acknowledgments

We thank Ching-Wen Chen (Hsinchu, Taiwan), Chin-Li Chiang (New Taipei, Taiwan), Harn-Ian Chiou (Keelung, Taiwan), Hsin-Chieh Tang (Taipei Zoo, Taipei, Taiwan), Jia-Han Lee (Yilan, Taiwan), Rui-Bin Song (Guangdong, China), Wen-Chi Yeh (Taiwan Forestry Research Institute, Taipei, Taiwan), Wen-Jang Liu (Kaohsiung, Taiwan). Wen-Liang Chang (Chiayi, Taiwan) and Yung-Chun Chou (Nanto, Taiwan) for providing photos and valuable records of *Sympetrum* spp. to our study and thank all citizen scientists who provide the distributional data to Nature Campus and Observation Database of Taiwanese Odonata. FSH thanks Ryo Futahashi (National Institute of Advanced Industrial Science & Technology, Tsukuba, Japan) for providing useful references. We appreciate Wen-Chi Yeh for improving our manuscript. We also appreciate the English editor of the TJES for polishing the paper.

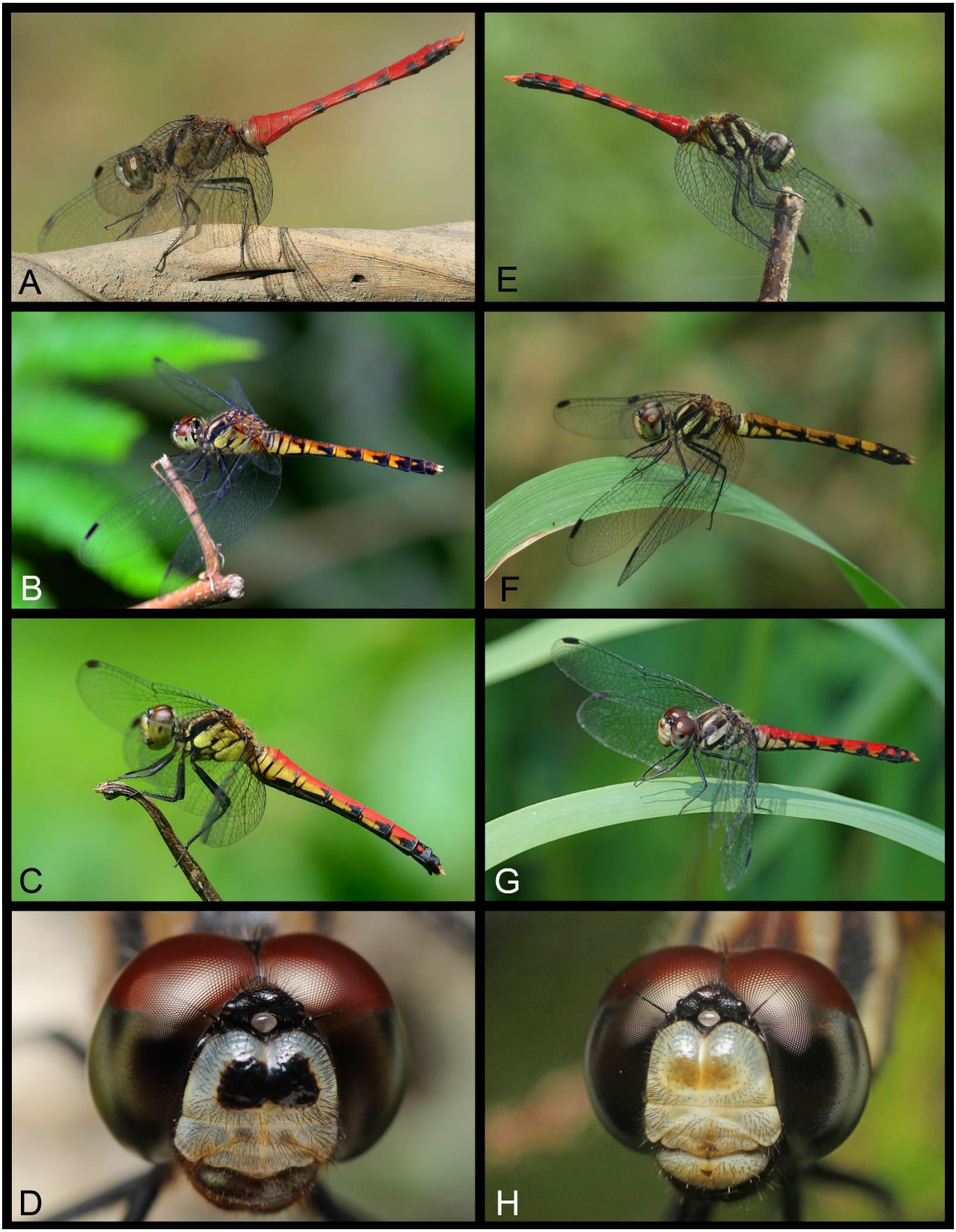

Figure 1. Live specimens of *Sympetrum eroticum ardens* (MaLachlan, 1894) and *S. nantouensis* Tang, Yeh & Chen, 2013: A–D, *S. eroticum ardens*: A, male; B, female (photo by C.-W. Chen); C, red form female (photo by J.-H. Lee); D, face of male. E–H, *S. nantouensis*: E, male; F, female (photo by Y.-C. Chou); G, red form female (photo by Y.-C. Chou); H, face of male.

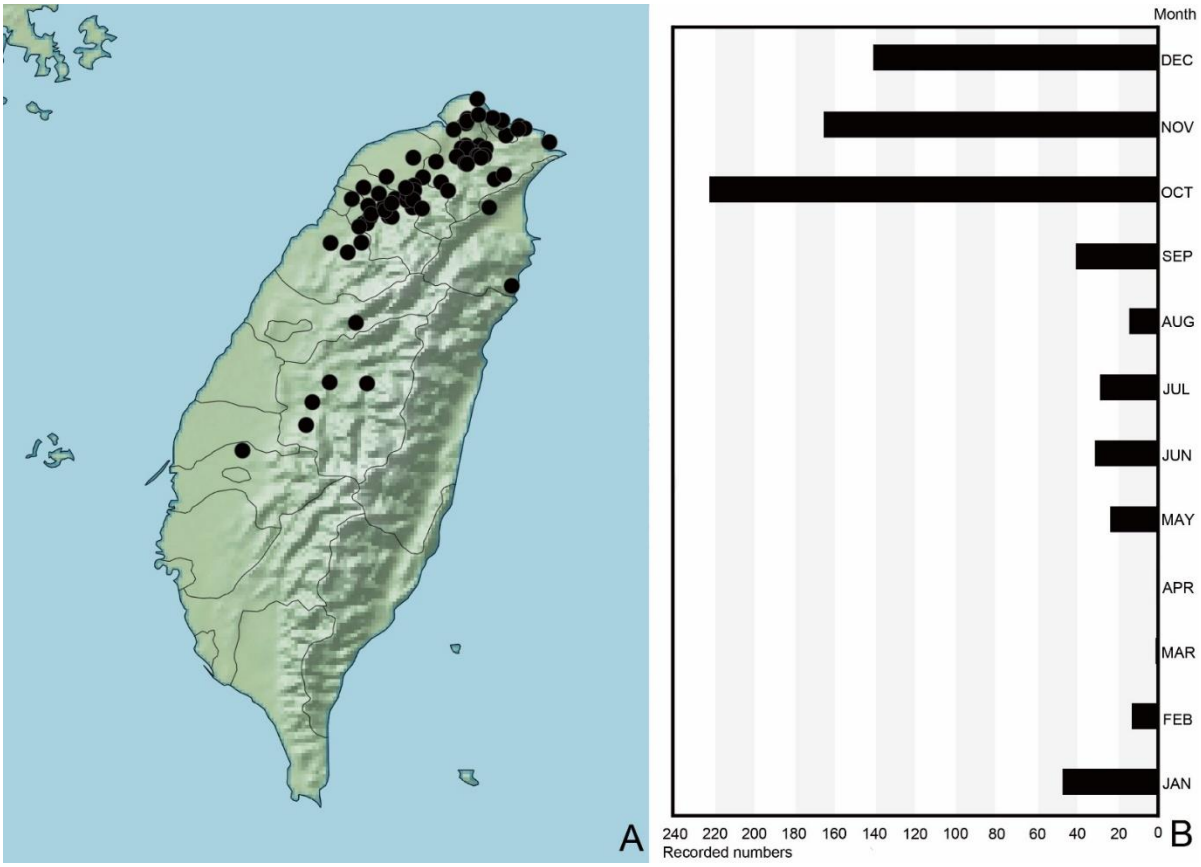

Figure 2. Distributional map and phenological graph of *Sympetrum eroticum ardens* (MaLachlan, 1894) in Taiwan. A, distributional map; B, phenological graph.

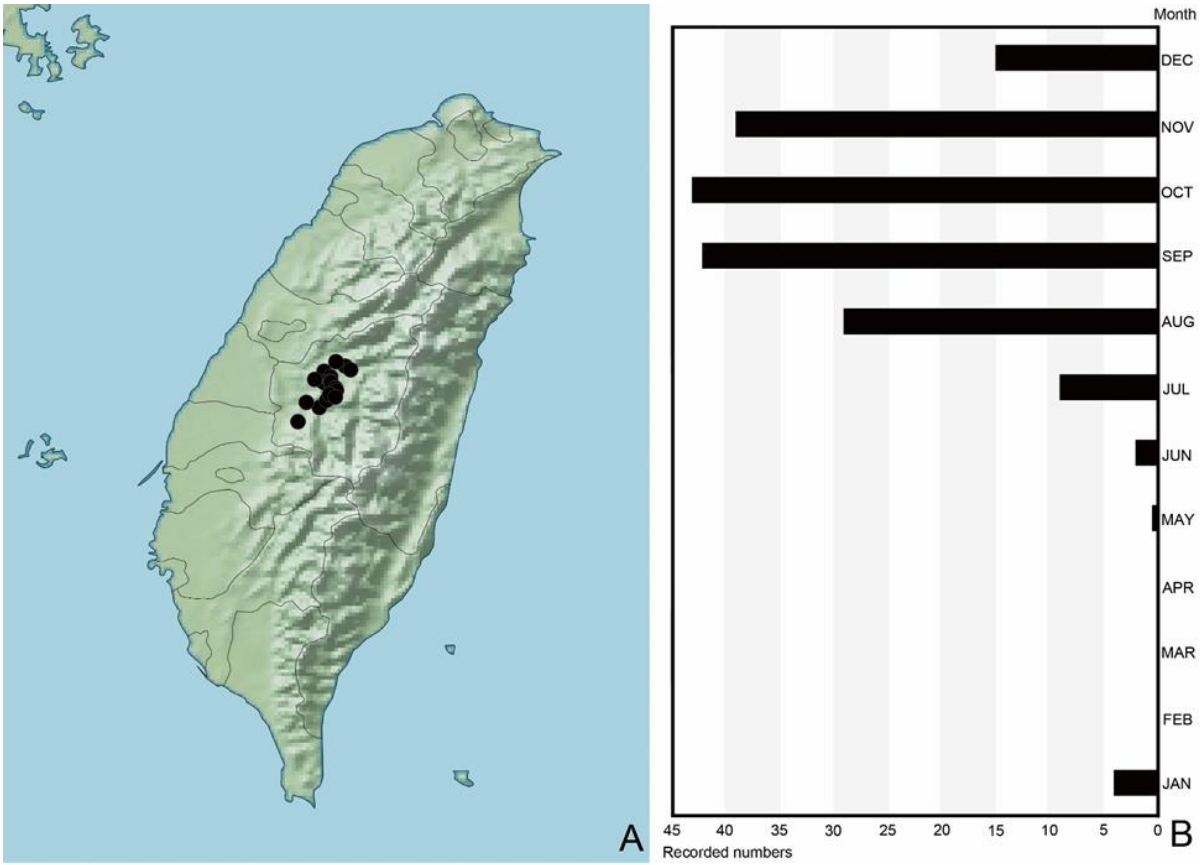

Figure 3. Distributional map and phenological graph of *Sympetrum nantouensis* Tang, Yeh & Chen, 2013 in Taiwan. A, distributional map; B, phenological graph.

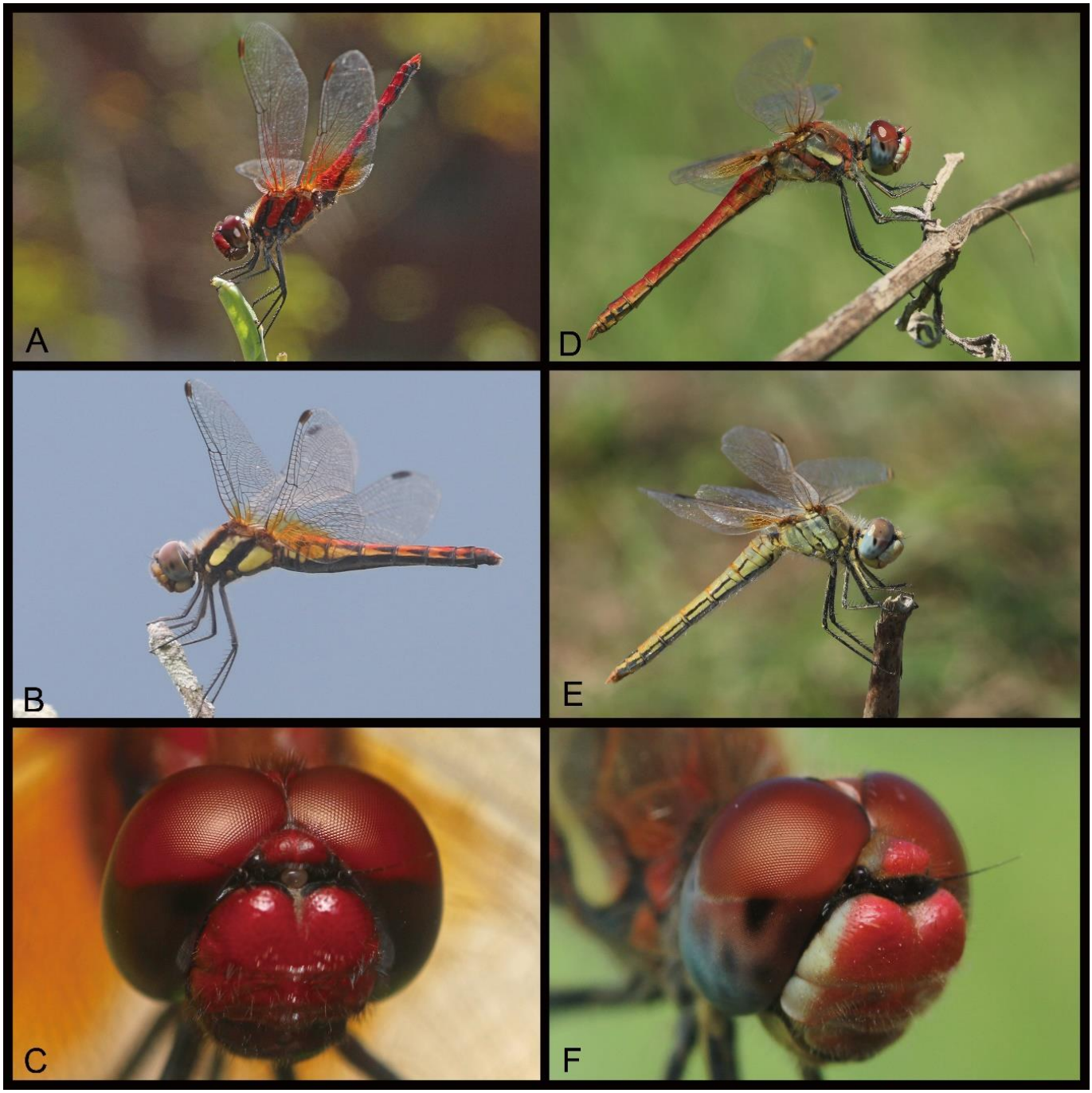

Figure 4. Live specimens of *Sympetrum speciosum* Oguma, 1915 and *Sympetrum fonscolombii* (Selys, 1840): A–C, *S. speciosum*: A, male; B, female (photo by W.-L. Chang); C, face of male. D–F, *S. fonscolombii*: D, male; E, female; F, face of male.

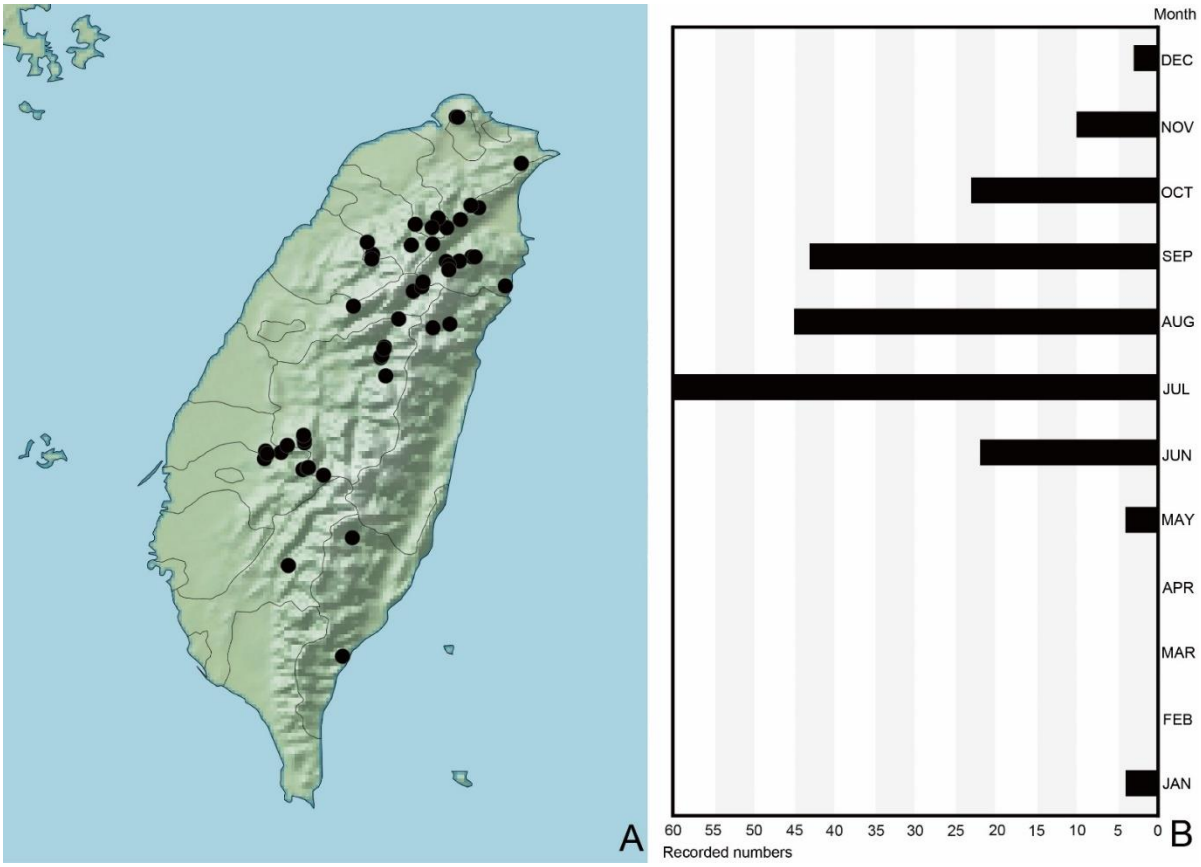

Figure 5. Distributional map and phenological graph of *Sympetrum speciosum* Oguma, 1915 in Taiwan. A, distributional map; B, phenological graph.

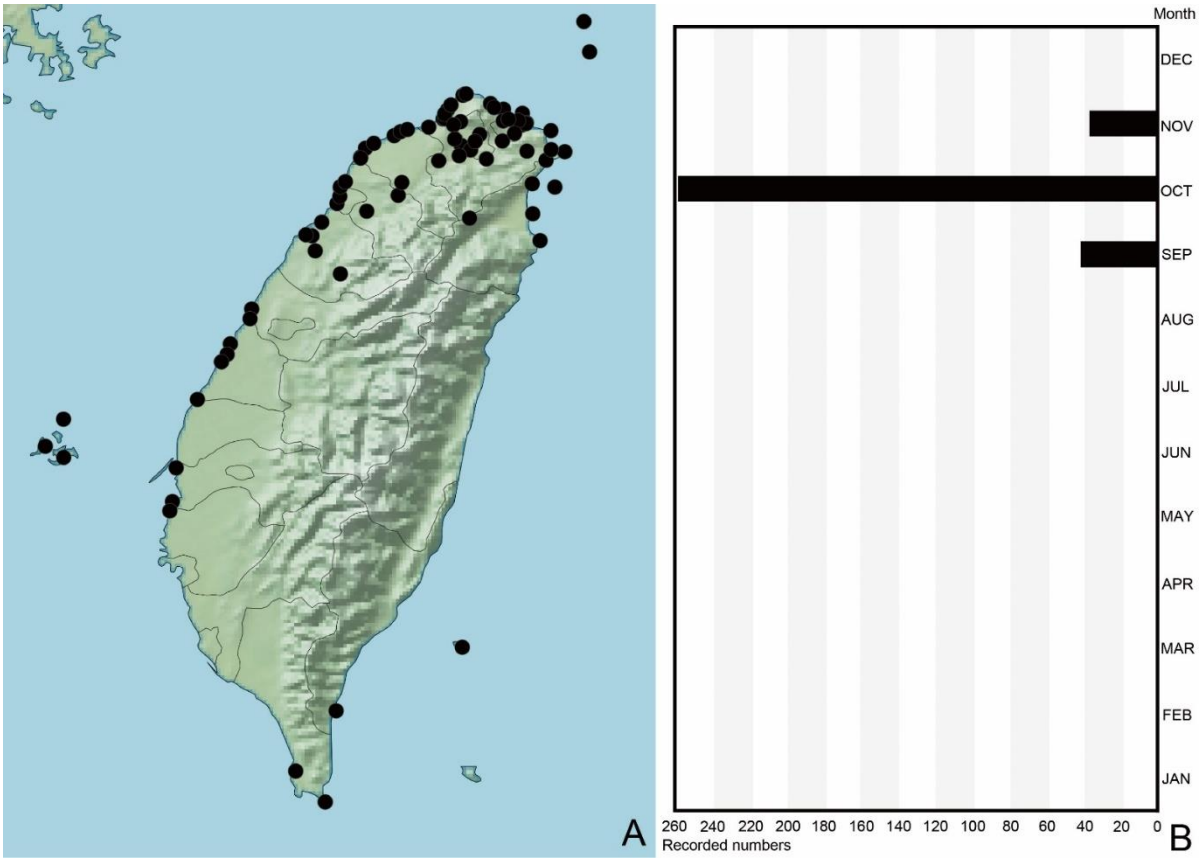

Figure 6. Distributional map and phenological graph of *Sympetrum fonscolombii* (Selys, 1840) in Taiwan. A, distributional map; B, phenological graph.

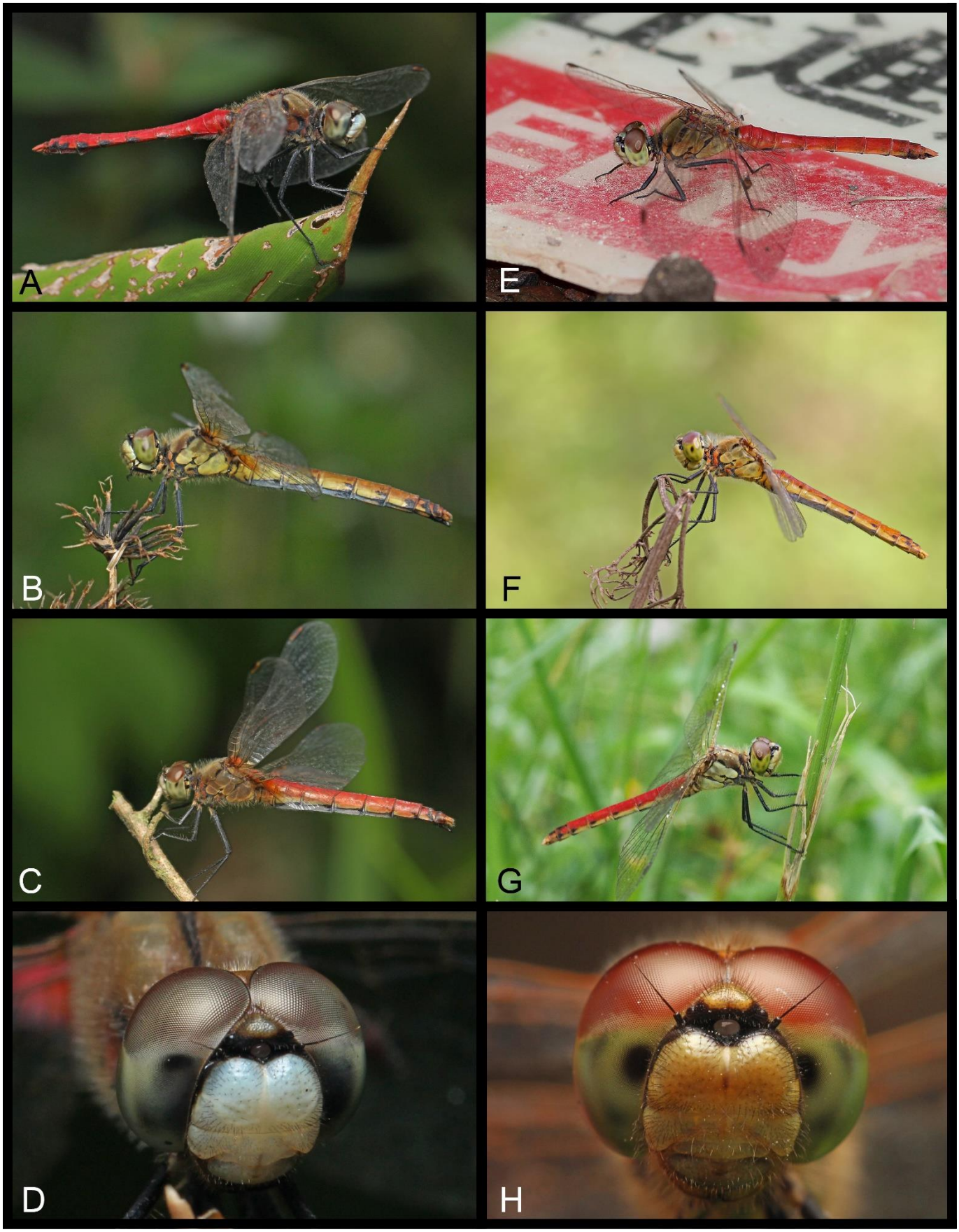

Figure 7. Live specimens of *Sympetrum cordulegaster* (Selys, 1883) and *S. depressiusculum* (Selys, 1841): A–D, *S. cordulegaster*: A, male; B, female; C, red form female; D, face of male. E–H, *S. depressiusculum*: E, male (photo by H.-I. Chiou); F, female; G, red form female; H, face of male.

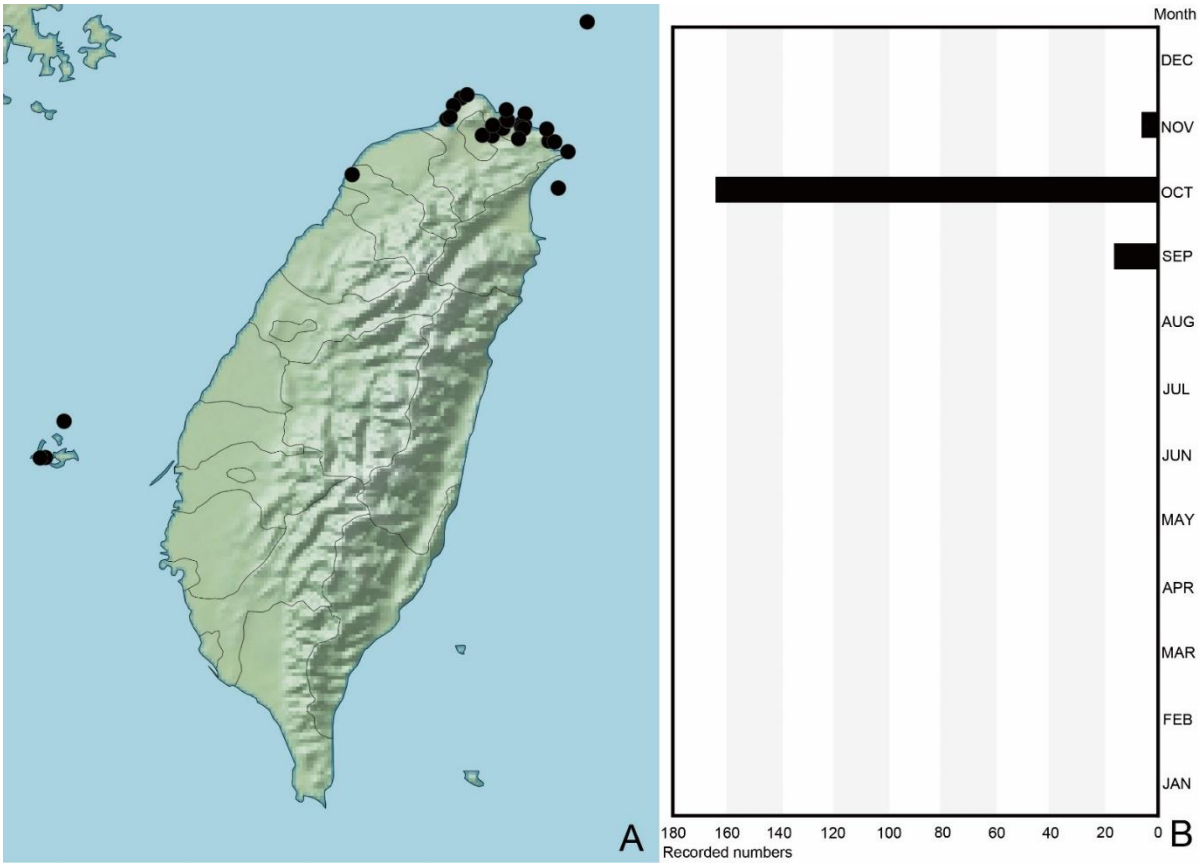

Figure 8. Distributional map and phenological graph of *Sympetrum cordulegaster* (Selys, 1883) in Taiwan. A, distributional map; B, phenological graph.

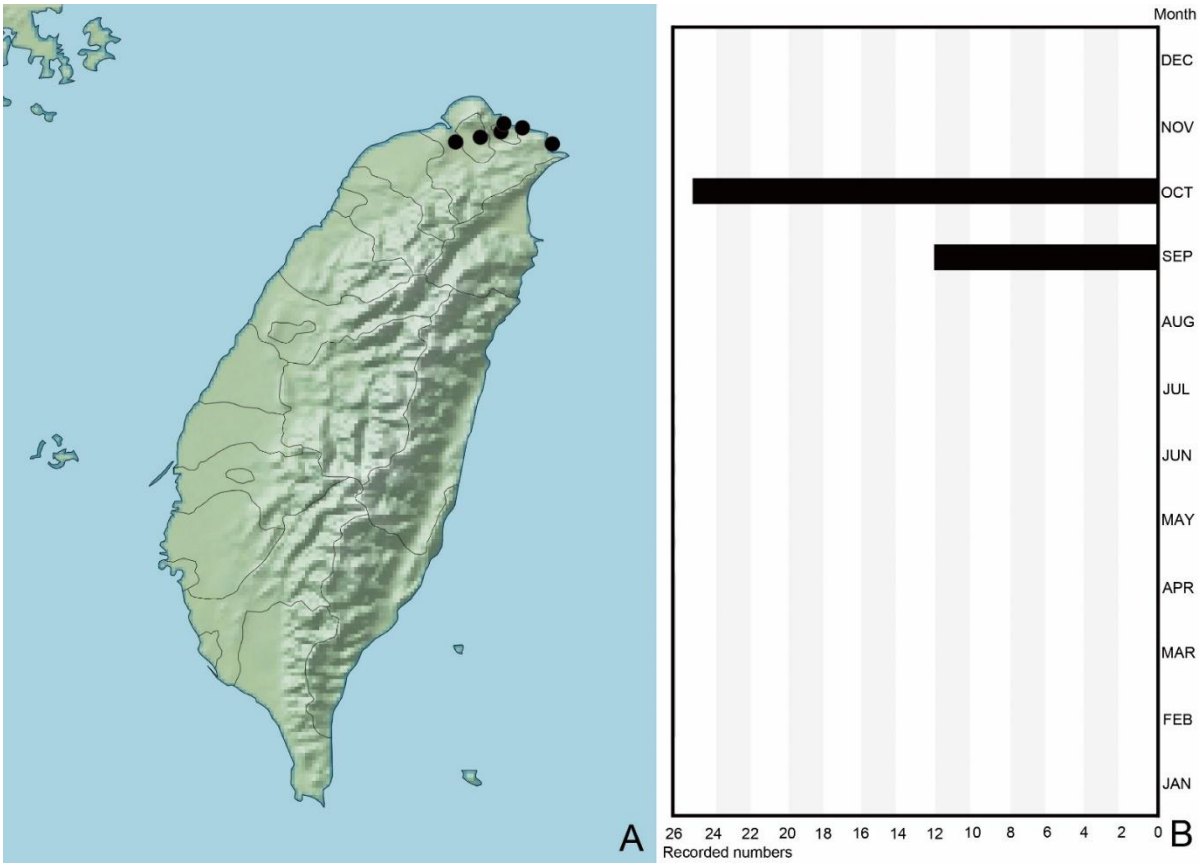

Figure 9. Distributional map and phenological graph of *Sympetrum depressiusculum* (Selys, 1841) in Taiwan. A, distributional map; B, phenological graph.

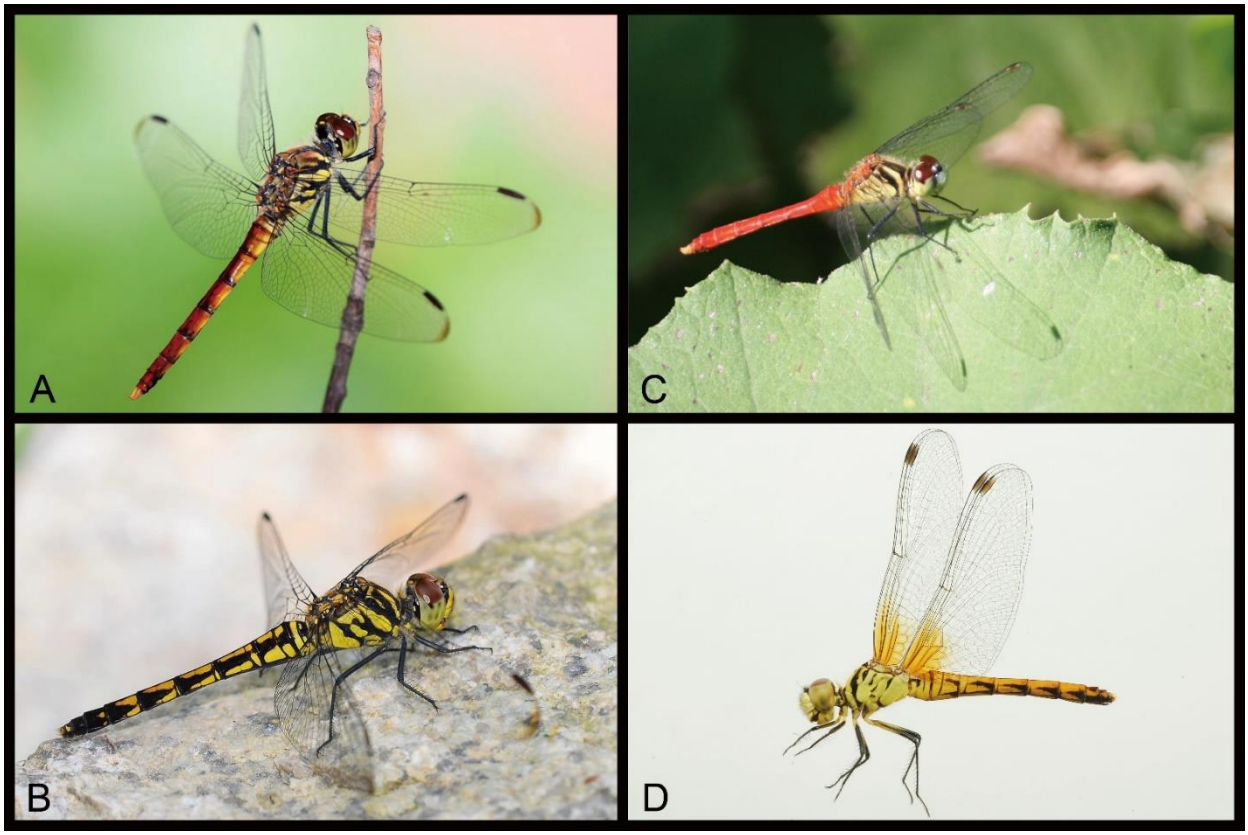

Figure 10. Specimens of *Sympetrum bacha bacha* (Selys, 1844) and *Sympetrum kunckeli* (Selys, 1884): A–B, *S. bacha bacha* (Specimens are from China): A, male (photo by R.-B. Song); B, female (photo by R.-B. Song). C–D, *S. kunckeli* (Specimens are from Japan): C, male (photo by H.-C. Tang); D, female (photo by W.-C. Yeh).

Figure 11. Live specimens of *Sympetrum darwinianum* (Selys, 1883) and *S. infuscatum* (Selys, 1883): A–B, *S. darwinianum* (Specimens are from Japan): A, male (photo by W.-J. Liu); B, female (photo by H.-C. Tang). C–D, *S. infuscatum* (Specimens are from Japan): C, male (photo by H.-C. Tang); D, female.

Figure 12. Live specimen of male *Sympetrum infuscatum* (Selys, 1883). Harn-Ian Chiou (秋寒煙) took the photo on 07 October 2009 in Qiuhong Lake (秋紅湖), Keelung City, Taiwan.

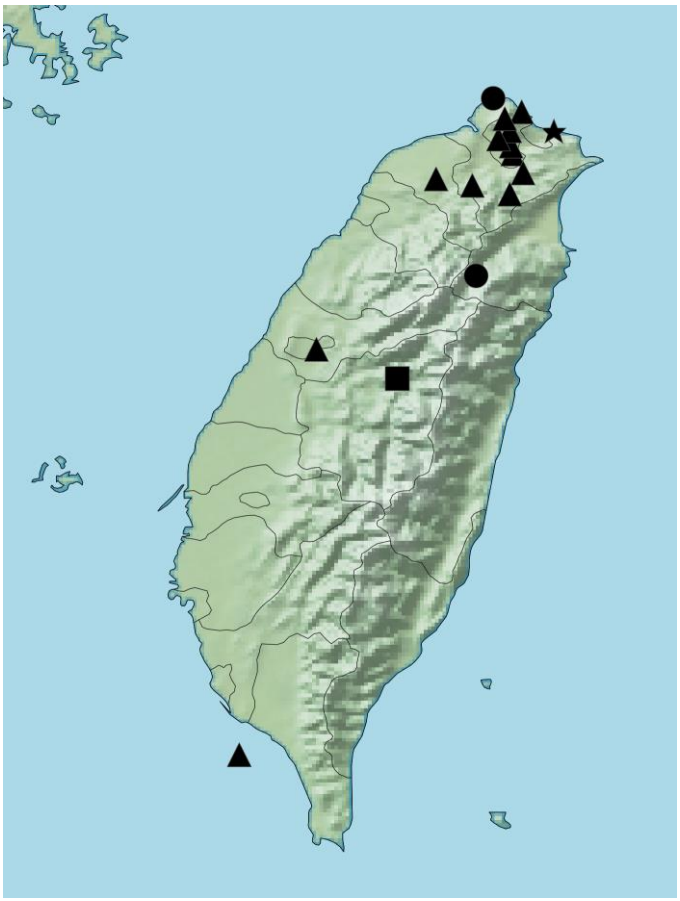

Figure 13. The distributional map of *Sympetrum bacha bacha* (Selys, 1844), *S. kunckeli* (Selys, 1884), *S. darwinianum* (Selys, 1883) and *S. infuscatum* (Selys, 1883) in Taiwan. Triangles represent *S. bacha bacha*; square represents *S. kunckeli*; circles represent *S. darwinianum*; star represents *S. infuscatum*.

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臺灣產赤蜻屬（蜻蜓目：蜻蜓科）：分布、生物學、新紀錄種報導

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摘要：本文提供臺灣產赤蜻屬生物學資訊、分布資訊及整體照，包含 10 個臺灣紀錄物種：赤衣蜻蜓 (*S. bacha bacha*)、長尾蜻蜓 (*S. cordulegaster*)、仲夏蜻蜓 (*S. darwinianum*)、秋紅蜻蜓 (*S. depressiusculum*)、焰紅蜻蜓 (*S. eroticum ardens*)、紅脈蜻蜓 (*S. fonscolombii*)、褐頂蜻蜓 (*S. infuscatum*)、孔凱蜻蜓 (*S. kunckeli*)、纖紅蜻蜓 (*S. nantouensis*)、黃基蜻蜓 (*S. speciosum*)。褐頂蜻蜓根據一張攝於 2009 年 10 月 7 日基隆市的照片首次記錄於臺灣，本文亦報導仲夏蜻蜓於 2010 年 10 月 9 日於新北市的發現，為本種在臺灣第二筆紀錄。基於 25 年來的公民科學資料，本文提供所有種類之分布地圖與部分種類 (長尾蜻蜓、秋紅蜻蜓、焰紅蜻蜓、紅脈蜻蜓、纖紅蜻蜓、黃基蜻蜓) 之出現月份紀錄狀況圖。

關鍵詞：蜻蜓、迷蜓、遷移、公民科學、生物學、東古北區、東方區

[研究文章 Research Article]

http://doi.org/10.5281/zenodo.7101070

First Report of the Family Scirtidae (Insecta: Coleoptera) from Kinmen Island and Lanyu Island, Taiwan

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Abstract: The beetle family Scirtidae comprises five genera and 15 species in Taiwan. Until now, Scirtidae were not known from the offshore islands of Taiwan. We report the first record of Scirtidae from Kinmen Island and Lanyu Island based on field research and examination of museum collections.

Keywords: new records, *Scirtes japonicus*, aquatic insect, offshore islands, Taiwan

Introduction

The family Scirtidae occur world-wide but are absent from arid areas (Watts & Kwick, 2019). They are common in wetlands where the larvae are mostly aquatic, but all adults are terrestrial insects. Five genera and 15 species are known in Taiwan (Miwa, 1931; Yoshitomi & Satô, 1996, 2004; Yoshitomi, 2001, 2005, 2010, 2012; Ruta, 2010), but until now, all records have been reported from Taiwan Island only.

Since 2020, we have been conducting research on the aquatic insect fauna of offshore islands in Taiwan, including the already published report on aquatic beetles of Penghu Islands (Liu et al., 2020), Dytiscidae and Hydrophilidae of Kinmen Islands and Lanyu Island (Liu et al., 2021; Liu et al., 2021; Wang et al., 2021). Based on this research, we have discovered six families of aquatic beetles, and the number of known species has increased from 16 to over 40. In this study, we report Scirtidae from Kinmen Island and Lanyu Island for the first time.

Materials and methods

All specimens were collected using water nets and light traps. Male genitalia were dissected from water-relaxed specimens and examined in temporary glycerine slides without cover glasses. The genitalia were then transferred directly to glycerine for examination. After the examination, the aedeagus was rinsed in 95% alcohol and mounted in Euparal on a small slide below the respective specimen. In some duplicate specimens, the aedeagus was mounted on the same card as the specimen using water-soluble glue. Male genitalia and morphological characters were examined using a Leica DM750 compound microscope.

The materials examined in this paper are deposited at the Department of Entomology, National Chung Hsing University, Taichung City, Taiwan (NCHU: Man-Miao Yang, Sheng-Feng Lin); the first author's collection (HCLC: Hsing-Che Liu's private collection, Hsinchu County, Taiwan) and Ehime University Museum (EUMJ).

Results

***Scirtes japonicus* Kiesenwetter, 1874**

日本圓花蚤

(Fig. 1)

Scyrtes japonicus Kiesenwetter, 1874: 244.

Scirtes japonicus: Pic, 1914: 42; Yano et al., 1983: 114 (Tainan).

稿件收到 *Received: 3 June 2022*

稿件接受 *Accepted: 15 September 2022*

稿件出版 *Published: 25 September 2022*

Material examined. TAIWAN: 5 ex., Hsinchu County, Beipu Township (北埔鄉), N24.70755 E121.06077, 29.III.2019, H.-C. Liu leg. (HCLC); 7 ex., Kinmen Island (金門島), 5–10.VII.2020, In the pond, H.-C. Liu leg. (NCHU, HCLC); 1 ♂, Taitung, Lanyu (蘭嶼), Kaiyuan Port (開元港), N22.059182 E121.509229, 14.V.2021, C.-H. Ma leg, by light (NCHU); 2 ex., Hualien County, Yuli Township (玉里鄉), N23.30001 E121.32647, 1.IV.2022, H.-C. Liu leg. (HCLC); 1 ex., Lanhsu, Taiwan, 5–10.VIII.1998, M. Sato leg. (EUMJ).

Diagnosis. Body length 3.8–4.3 mm. Body elongate, dorsal surface darker brown (Fig. 1A, C); Metatibia are rather well developed; Median lobe slightly longer than parameres, wide basally, narrowing at apex, but slightly rounded at ca.1/9; parameres very slender (Fig. 1B).

Distribution. This species is widely distributed in Eastern Asia, Hawaii Islands; it is a common species at low altitude in Taiwan (Yano et al., 1983; Yoshitomi, 2005, 2008), Kinmen Island. (new record) and Lanyu Island. (new record).

Bionomics. This species inhabits stagnant water pools with rich aquatic plants (Fig. 1D). Some specimens can be collected from light traps.

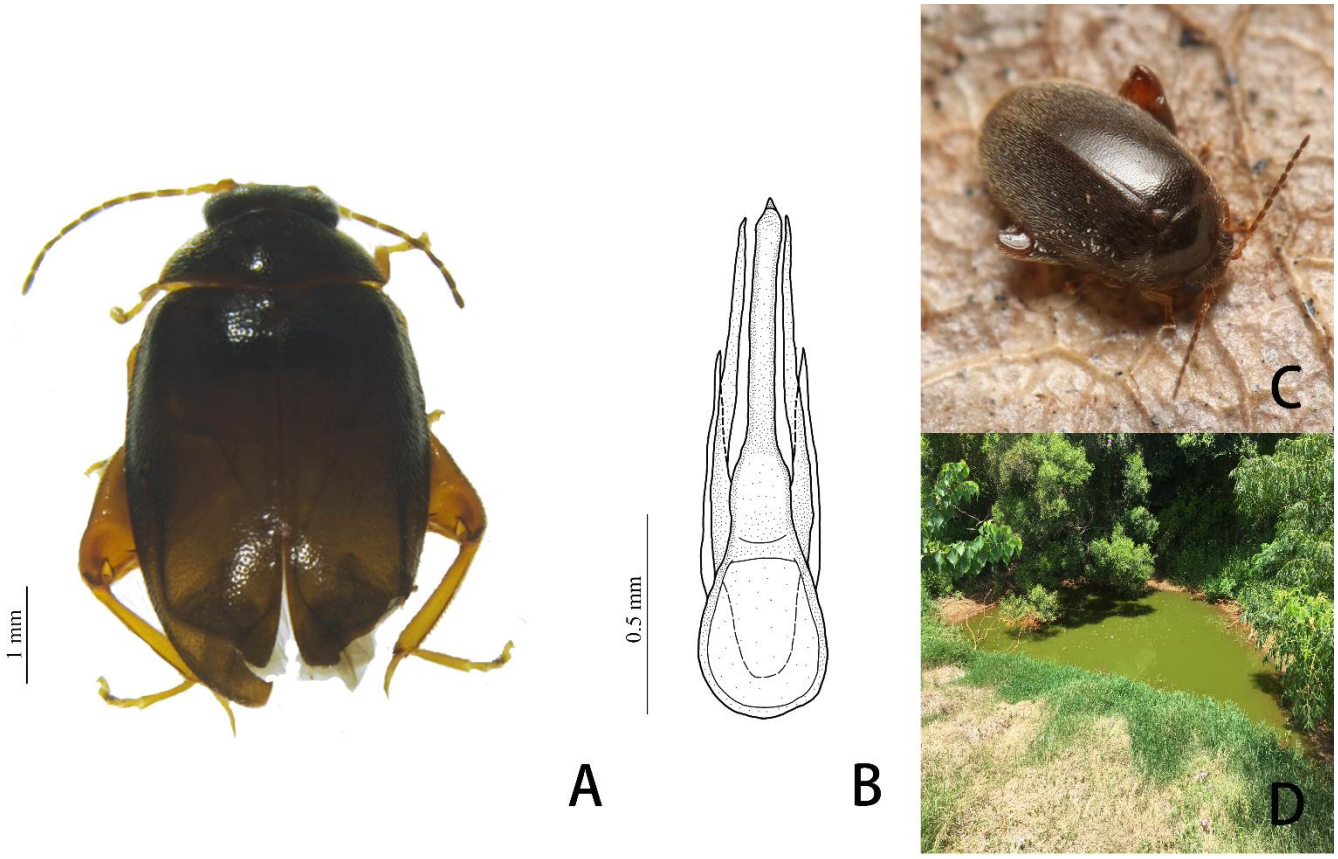

Figure 1. *Scirtes japonicus*. A – dorsal habitus; B – male genitalia, dorsal view; C – living individual, photo from Lanyu Island, photo by C.-H. Ma; D – habitat, from Kinmen Island.

Acknowledgements

The first author is grateful to the Laboratory of Urban Entomology, Department of Entomology, National Chung Hsing University, including Hou-Feng Li and Chia-Chien Wu, for providing photographic equipment. We are indebted to two anonymous reviewers who helped to improve this manuscript a lot.

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臺灣金門島及蘭嶼的圓花蚤科（昆蟲綱：鞘翅目）首次報告

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摘要：圓花蚤科在臺灣已知 5 屬 15 種，但臺灣離島尚未有圓花蚤科的報導。本研究根據實地考察和博物館標本檢查，首次報導金門群島和蘭嶼的圓花蚤科紀錄。

關鍵字：新紀錄、日本圓花蚤、水棲昆蟲、離島、臺灣

[科學短訊 Scientific Communication]

http://doi.org/10.5281/zenodo.7101190

A Case of Pupa Adheraena in *Amphiops mater* Sharp (Coleoptera: Hydrophilidae)

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Abstract: The pupae of *Amphiops* were often observed attached horizontally to twigs or floating objects. In the present paper, the author reports a case of pupa adheraena in *A. mater* Sharp, 1873, which was hanging under a plastic cover under artificial conditions. Furthermore, the potential morphological adaptations for the floating behavior in *Amphiops* pupae are discussed.

Keywords: Pupation, behavior, water scavenger beetle, immature stage

Pupation is a crucial stage for holometabolous insects in which morphology and internal anatomy transforms from larval to adult. *Amphiops* beetles form the basal clade of the family Hydrophilidae (Short & Fikáček, 2013), implying that understanding their biology will improve our knowledge of the evolution of the family. Furthermore, the pupation behavior of *Amphiops* is unique in the family. Their pupae either attached their head to twigs (Watts, 2002) or float on the water after pupation (Kuwabara & Hayashi, 2022), in contrast to most other aquatic hydrophilid larvae which build a pupal chamber on the ground. In the present paper, the author reports an observation of pupa adheraena in *Amphiops mater* Sharp, 1873 under artificial conditions.

The larvae of *A. mater* were obtained during captive breeding. The beetle larvae were kept in a small plastic cup with tissue paper at the bottom and shallow water at room temperature. In addition, the frozen larvae of *Chironomus* sp. were provided for the beetle larvae as a food source.

Most individuals (n > 20) pupated on the surface of tissue paper or attached to the plastic wall of the cup. A single individual attached its exuvia to the plastic cover of the cup, and pupated partly enclosed in the larval exuvia, with the larval head attached to the pronotal part of the pupa (Fig. 1). After two days, the beetle failed to eclose and died.

The Australian *A. queenslandicus* Balfour-Browne used their head attached to the twigs when pupating, but how they attached to the surface remains unknown (Watts, 2002). The pupae of *A. mater* can be easily removed from the twigs on which they pupate (Kuwabara & Hayashi, 2022). It remains unclear whether the different pupation behavior is due to variation between species or other factors. Regarding the pupa adheraena of *A. mater*, it is possible that the larva failed to remove the head exuvia, leading to it not easily leaving the larval exuvia like other individuals. The unusual morphology of the pupa of *Amphiops* was noticed by Watts (2002). The absence of setae and the presence of flaky appendages along the lateral side of the abdomen may provide an advantage for floating and the shield-like dorsal surface may help the beetles evade predators. Both characters are considered as potential morphological adaptations for the floating behavior observed in Kuwabara & Hayashi (2022). Further observations of the pupation of *Amphiops* are needed to understand the pupation biology and survival strategy of the beetles.

The author thanks Hsing-Che Liu (Hsinchu, Taiwan), I-Lung Lee (New Taipei, Taiwan), and Martin Fikáček (Kaohsiung, Taiwan) for the assistance during the field collecting of the parental generation of the *Amphiops* beetles. I thank the reviewers provide the comments to improve the quality of the paper. I also appreciate the English editor of TJES for checking the English for the manuscript.

稿件收到 *Received: 5 August 2022*

稿件接受 *Accepted: 27 August 2022*

稿件出版 *Published: 25 September 2022*

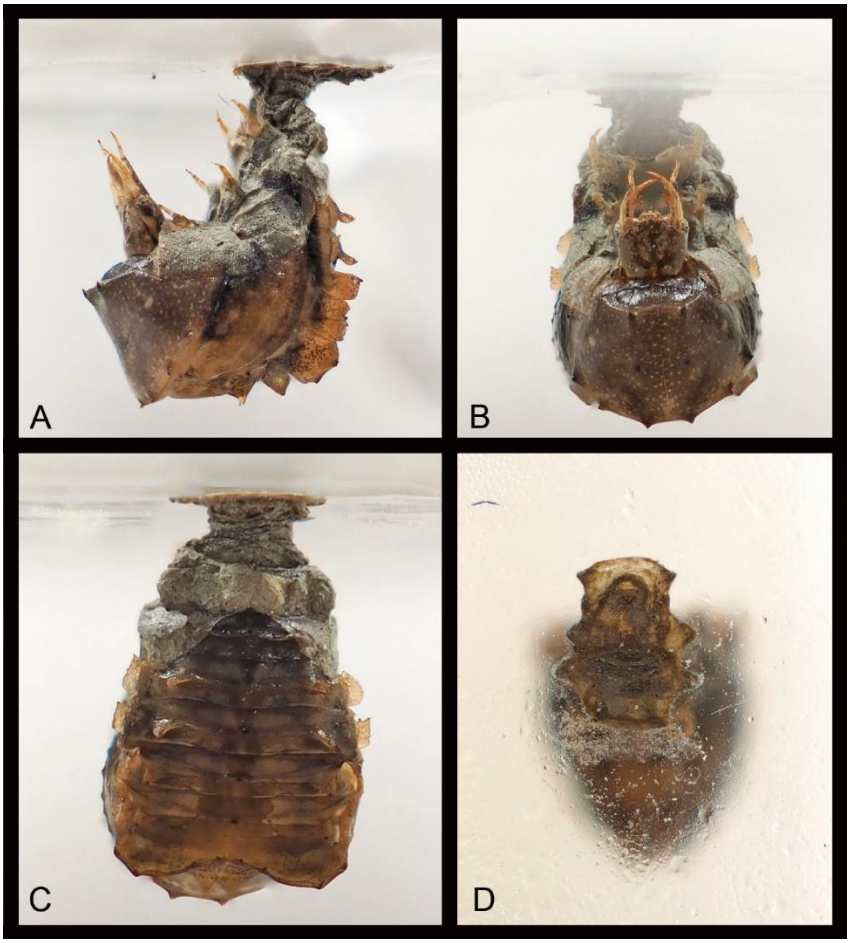

Figure 1. The pupa adheraena of *Amphiops mater* Sharp, 1873. A, lateral view; B, anterior view; C, posterior view; D, the attached point of the larval exuvia.

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瑪球牙蟲吊蛹案例（鞘翅目：牙蟲科）

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摘要：大多數球牙蟲屬 (*Amphiops*) 化蛹時多被觀察到水平依附在枝條或漂浮物上，本文作者報導瑪球牙蟲 (*A. mater* Sharp) 吊蛹的紀錄，其在人工環境下懸掛於塑膠蓋下方。本文亦討論球牙蟲的蛹對於漂浮行為可能地形態適應。

關鍵字：化蛹、行為、牙蟲、幼生期

[科學短訊 Scientific Communication]

http://doi.org/10.5281/zenodo.7101242

New Records of *Creophilus flavipennis* (Hope, 1831) from Taiwan Island and Lutao Island, Taiwan (Coleoptera: Staphylinidae)

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Abstract: *Creophilus flavipennis* (Hope, 1831) is reported from Taiwan island and Lutao Island for the first time. Based on iNaturalist data, new province records of the species from Hong Kong, Macao and Hainan in China are also provided. Finally, the recent records of *C. flavipennis* in East Asia are briefly discussed.

Keywords: Fauna, Oriental region, citizen science, East Asia, rove beetle

Creophilus flavipennis (Hope, 1831) is widely distributed in the Oriental and southeastern Palearctic regions, with a doubtful record from New Guinea (Clarke, 2011). Records of the species in East Asia currently include Iriomote-Jima Island, Japan (Hayashi & Shôyama, 2013), and Kinmen Island and Lanyu Island, Taiwan (Hu, 2020; Chou & Hayashi, 2020). Hu (2020) predicted *C. flavipennis* might also occur on Taiwan island due to the disjunction between Kinmen island and Lanyu Island. In the present paper, we report the first specimen of *C. flavipennis* from Taiwan island, which supports the prediction of Hu (2020). Further records of *C. flavipennis* were extracted from iNaturalist, and new provincial records of the species are provided.

The examined specimens are deposited in the following institutions: FSHc—Fang-Shuo Hu, private collection, Yilan, Taiwan; BHHc—Bin-Hong Ho, private collection, Taipei, Taiwan; NMNS—National Museum of Natural Science, Taichung, Taiwan (J.-F. Tsai); PYHc—Pai-Yu Huang, private collection, Changhua, Taiwan. The records from iNaturalist are summarized in Supplementary data I (http://doi.org/10.5281/zenodo.7033852).

Material examined. TAIWAN: Pingtung County: 1 ♂, Shihtzu, Shouka (壽卡), 300m, 2022,IV-25, Leg. Yi-Ting CHUNG, CCCC (NMNS); 1 ♂ 1 ♀, Neiwen (內文), Shizi Township, 25-II-2022, leg. P.-Y. Huang by HID light trap (PYHc). **Taitung County:** 2 ♂♂ 5 ♀♀, Lutao Is., Nanliao village (南寮村), alt. 125 m, 22.66545°N 121.47758°E, 21.VI.2022, B.H. Ho leg. (LT) (NMNS, FSHc, BHHc); 1 ♀, Lutao Is., Mt. Amei (阿眉山), 22.65827°N 121.49265°E, alt. 276 m, 23.VI.2022, B.H. Ho & Y. Ho leg. (LT) (BHHc).

Remarks. The pubescence on the elytra of specimens from Lutao Is. (Fig. 1) is relatively darker than those from other localities.

Based on our results and the records from iNaturalist, new records of the species from Taiwan Island, Green Island, Hong Kong, Macao and Hainan are reported for the first time. It is still uncertain whether the current distribution of *C. flavipennis* in East Asia is due to natural or human-assisted dispersal, or the result of range shifts due to climate change. Within the genus *Creophilus*, *C. maxillosus* and *C. erythrocephalus* are reported as introduced species in Southern America and Hawaii, but the dispersal abilities of these species are also uncertain (Newton, 1997; Navarrete-Heredia et al., 2002; Asenjo & Clarke, 2007). The island hopping dispersal abilities of *Creophilus* species may be a pivotal point in solving such a question.

We thank Chang-Chin Chen, Pai-Yu Huang, Yi-Ting Chung and Yun Ho for providing valuable specimens for the study. The first author thanks Alfred Newton (The Field Museum, USA) for providing literature. We also thank the reviewers and the English editor of TJES for providing comments that improved our paper.

稿件收到 *Received: 29 July 2022*

稿件接受 *Accepted: 30 August 2022*

稿件出版 *Published: 25 September 2022*

Figure 1. Habitus of male specimen of *Creophilus flavipennis* (Hope, 1831) from Lutao Island.

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橙翅嗜肉隱翅蟲於臺灣本島與綠島之新紀錄（鞘翅目：隱翅蟲科）

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摘要：橙翅嗜肉隱翅蟲被首次記錄於臺灣本島與綠島，基於 iNaturalist 的資料，此種亦首次記錄於香港、澳門與海南，本文亦簡短討論橙翅嗜肉隱翅蟲近期於東亞地區的擴散事件。

關鍵字：動物相、東方區、公民科學、東亞、隱翅蟲

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網站 (Website)：http://taisocinh.wixsite.com/taisocinsectnhweb

出版年月 (Date of publication)：西 元 2022 年 9 月 25 日

創刊年月 (First date of publication)：西 元 2016 年 12 月 25 日

刊期頻率 (Frequency)：季刊

臺 灣 昆 蟲 同 好 會

Taiwanese Society of Insect Natural History

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